REPORT

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DISPERSION MODELING PROTOCOL

Prepared for
Solvay Minerals

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1.1 PROJECT DESCRIPTION

The existing Soda Ash production plant will be expanded and modified within the same property boundaries to allow an additional 1.2 million tons per year (TPY) of Soda ash production. This will increase the total production to approximately 3.6 million TPY. The proposed modification will include a new shaft and hoist to recover ore from the mine, a new crusher and screens, and an additional covered storage area for 50,000 tons of ore. A fourth crusher will be added to the existing crusher facility, and a new calciner capable of calcining 400 tons/hr of ore and having a heat input capacity of 400 Mbtu/hr will be installed and equipped with a new Electrostatic precipitator (ESP). The new line for processing the ore will include three mechanical vapor recompressive (MVR) Crystallizers, filters and a Natural Gas fired dryer. The dryer will have a capacity of approximately 200 million BTU/hr, and will be controlled with an ESP. Additional product storage facilities will be constructed, but the loadout facility will not be changed, except that now it will operate almost continuously.

The modifications will be phased over approximately five (5) years. During the second quarter of 1999 the first phase will be completed by bringing on-line the 4th crusher for the existing crusher facility, the new calciner, the dryer and one of the three proposed MVR crystallizers. This will allow an increase in production of approximately 400,000 TPY.

In January of 2001, the second phase will be completed with the installation of the second MVR crystallizer, the new primary crusher and screens, the ore storage area and the new product silos. This will also increase production by approximately 400,000 TPY

In January of 2003, the third MVR crystallizer will be brought on line resulting in the final production increase of 400,000 TPY.

The proposed modifications will result in an increase of particulate emissions, both total suspended particulate (TSP) and particulate matter less than 10 microns in diameter (PM_{10}), an increase of Nitrogen Oxides (NO_x) emissions, and an increase of Volatile Organic Compounds (VOCs) emissions in excess of the deMinimus emission levels set for existing major stationary sources. Recently, the project has modified the fuel and burners on the existing calciners, resulting in a reduction of approximately 600 TPY of NO_x emissions. Considering this recent reduction to offset the proposed increase will result in a net decrease in the total amount of NOx emissions from the project. As a result, PSD permitting requirements and review are triggered for the particulate emissions and the VOC emissions only.

Emissions of other criteria pollutants, sulfur dioxide (SO_2), and carbon monoxide (CO) are below the deMinimus emission levels and are not subject to PSD review.

1.2 MODELING PROCEDURE

This protocol details the procedures that will be followed in the modeling analysis. This analysis will follow guidelines established by the Wyoming Department of Environmental Quality (WDEQ). In general, air quality modeling will be performed to show compliance with the following:

- PSD increments for PM_{10},

- NAAQS for all criteria pollutants, and
- Wyoming specific standards (i.e., 24-hour TSP, 24-hour SO_2, etc.)

Although the project will result in an increase in VOC emissions, no modeling demonstration is proposed because there is not an accepted methodology that adequately addresses the complex interactions of VOC's in the atmosphere. HAPs will be addressed separately even though there are no Federal Class I areas located within 100 Kilometers of this site. The project intends to provide an assessment of the potential impact to visibility using a screening model (VISCREEN). In addition, the project will identify the maximum distance at which the potential impacts drop below the Class I area significant impact levels.

In the event that the proposed project has a significant air quality impact, then attainment of the ambient air quality standards must be documented. A discussion of the ambient air quality standards and method of documenting compliance with these standards is outlined in the following sections. A discussion on the applicable regulations and associated modeling requirements is also provided below.

2.1 AMBIENT AIR QUALITY STANDARDS

In 1970 the United States Congress instructed the Environmental Protection Agency (EPA) to establish standards for air pollutants which were of nationwide concern. This directive resulted from the concern regarding the effects of air pollutants on the health and welfare of the general public. The resulting Clean Air Act (CAA) set forth air quality standards to protect the health and welfare of the general public with an adequate margin of safety. Two levels of standards were promulgated: primary standards and secondary standards. Primary national ambient air quality standards (NAAQS) are "those which, in the judgment of the Administrator (of the EPA), based on air quality criteria and allowing an adequate margin of safety, are requisite to protect the public health (state of general health of the community or population)." The secondary NAAQS are "those which in the judgment of the Administrator (of the EPA), based on air quality criteria, are requisite to protect the public welfare and ecosystems associated with the presence of air pollutants in the ambient air."

To date, NAAQS have been established for six contaminants termed "criteria pollutants": sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), sub 10-micron particulate matter (PM_{10}), and lead (Pb). The criteria pollutants are those that have been demonstrated historically to be widespread and have a potential for adverse health impacts. EPA developed comprehensive documents detailing the basis of, or criteria for, the standards that limit the ambient concentrations of these pollutants. The WDEQ has established Wyoming ambient air quality standards that are consistent with the national standards. The NAAQS are listed in Table 1.

The EPA has designated all areas of the United States as having achieved the NAAQS (attainment areas) or not achieved the NAAQS (non-attainment areas). The region is currently designated as attainment for all criteria pollutants.

2.2 AMBIENT AIR QUALITY ANALYSES

The EPA has defined a set of significant impact levels (SILs) which are used to determine whether a detailed air quality impact analysis needs to be performed to assess attainment of the NAAQS. The SILs are presented in Table 2. By modeling project air quality impacts, if impacts from the proposed project exceeds the SILs for any of the criteria pollutants, then a detailed NAAQS compliance demonstration must be performed. The primary purpose of comparing a source's modeled concentrations with the SILs is to establish the source's area of significant impact for each pollutant and time-averaging period. The significant impact area is defined by a circle whose radius is equal to the location of the furthest receptor whose concentration is predicted to exceed the SIL.

To demonstrate compliance with the air quality standards, impacts from the proposed project must be modeled and superimposed on the predicted impacts from other existing major sources (background sources) within and around the project's significant impact area. A listing of the background sources and associated modeling input parameters will be obtained from the Department if a compliance demonstration is required. If the project contribution does not exceed the SILs, then evaluation of cumulative impacts (background source interaction modeling) is not required.

To account for regional background levels and impacts from sources that were not included in the background source interaction modeling as "major sources", a measured background concentration is added to the predicted impacts from the proposed project and the other existing major source impacts. This total concentration is then compared to the NAAQS to assess attainment. This procedure can result in overestimates of total concentrations because the effect of some sources are double-counted if they are both modeled and also contribute to a regional background measurement value. If use of the highest measured background concentration results in an exceedance of the NAAQS then the background measurements will be further evaluated to determine if the same sources are being double counted in both the modeling and monitoring data and whether either of the data bases should be adjusted. If adjustments to either data base are required, then procedures for adjustment of the data will be submitted to the Department for approval prior to making the adjustments.

2.3 PREVENTION OF SIGNIFICANT DETERIORATION AND NEW SOURCE REVIEW

The EPA has delegated to WDEQ the authority and responsibility for administering the federal New Source Review (NSR) and Prevention of Significant Deterioration (PSD) program in Wyoming. As such, WDEQ is the regulatory agency responsible for review of a proposed project application and the subsequent issuance of the operating permit. For sources located in an attainment area, PSD review includes a Best Available Control Technology (BACT) analysis, NAAQS compliance demonstration, air quality increment analysis, assessment of Class I and Class II impacts, and an assessment of air quality related values.

To evaluate PSD applicability for the expansion project, the annual potential emissions from each project were computed along with emissions from other directly related project constructed within a 5-year contemporaneous period. The estimated annual potential emissions were then compared to the PSD applicability thresholds. The PSD "significant net emission increase" thresholds and estimated annual potential emissions from each project are listed in Table 3. Potential emission increases of VOC and PM_{10} from the expansion project will exceed the PSD thresholds; therefore these two pollutants are evaluated in the PSD analysis

For each pollutant subject to PSD review, the air quality analysis must determine NAAQS compliance, as discussed above, and must evaluate the amount of PSD increment that is available to the new source, as well as the potential amount of increment that the new source is expected to consume. The regulatory PSD increments are presented in Table 4.

3.1 AIR QUALITY AND METEOROLOGICAL DATA SOURCES

Surface meteorological data for Rock Springs, Wyoming and upper air data from Lander, Wyoming were obtained. A 5-year database will be supplied by WDEQ to be used in all refined modeling analyses. If a NAAQS compliance demonstration is required, background ambient air quality data will be provided by WDEQ. A summary of the air monitoring data will be provided by WDEQ.

3.2 DISPERSION ENVIRONMENT

The dispersion characteristics of the region surrounding the site of the Solvay Plant were classified in accordance with Auer (1978) land use classification methodology. Based on review of the surrounding region in accordance with the Auer method, the region meets the criteria for rural classification. Therefore, rural dispersion coefficients will be used in this modeling analysis.

3.3 MODELING CORRECTION

Compliance with the AAQS and PSD increments will be assessed using the following method to correct modeling results to standard conditions. This will be done using the following equation

$$C_{stp} = C_m * (P_{stp}/P_{fac}) * (T_{fac}/T_{stp})$$

where:

correction unnecessary

C_{stp} = concentration at standard conditions ($\mu g/m_3$)

C_m = modeled concentration ($\mu g/m_3$)

P_{stp} = standard pressure (1013 mb)

P_{fac} = estimated average pressure at the elevation of the facility (mb)

T_{fac} = annual average temperature measured at the facility (K)

T_{stp} = standard temperature (K)

4.1 OVERVIEW

To predict maximum ground level concentrations (GLC), two EPA Gaussian dispersion models will be used to calculate project related air quality impacts. Two levels of modeling will be performed: a screening analysis and a refined analysis. These models, including input options used in the analysis, are discussed below. Table 5 presents an overview of the models that will be used in the air quality impact analysis.

A visibility screening model VISCREEN will be utilized to assess the potential impact of the project to visibility.

4.2 SCREENING MODELING

The EPA screening model SCREEN3 (Version 96043) will be used for the screening modeling analysis.

A screening analysis is used: 1) to identify which project operating scenario results in the worst case air quality impacts for input into the refined modeling, and 2) to determine the final receptor locations to be used in the refined modeling. The methods used to conduct the screening analysis are discussed below.

For the expansion project, emissions and stack parameters exhibit variations based on operating load. Therefore, in order to assess the worst-case air quality operating scenarios, a screening analysis is performed to evaluate each operating scenario, and to identify the conditions likely to produce the highest impacts on a pollutant-specific basis. The operating scenario that results in the worst-case air quality impacts will be modeled in the refined modeling analysis. The applicable operating scenarios are discussed in Section 1.1.

A cavity impact analysis will also be performed using SCREEN3 to determine if off-site cavity impacts exceed the modeled simple, intermediate and complex terrain impacts.

4.3 REFINED MODELING ANALYSIS

The ISCST3 model (Version 96113) (USEPA, 1995), which is a simple and complex terrain refined model, was selected for the refined (sequential) modeling. The ISCST3 model will be used to predict impacts for all terrain types, including intermediate and complex terrain receptors.

The ISCST3 model will be used with hourly surface meteorological data collected at the Rock Springs National Weather Service (NWS) Station and upper air data from Lander, Wyoming. The meteorological data to be used in the refined analysis covers a 5-year period.

The ISCST3 model is a steady-state, multiple-source, Gaussian dispersion model. ISCST3 also treats complex phenomena such as building-induced plume downwash and the gravitational settling and deposition of particulate matter.

Technical options selected for the ISCST3 modeling are listed below. Use of these options follow EPA's (1987b, 1993) modeling guidance and/or sound scientific practice. An explanation of these options and the rationale for their selection is provided below. The required input options for ISCST3 are as follows:

- Rural Dispersion Coefficients
- Final plume rise
- Stack tip downwash
- Buoyancy induced dispersion
- Calm processing
- Default wind profile exponents
- Default vertical temperature gradients
- Anemometer height = to be determined by WDEQ

Final plume rise is recommended by EPA when there is no significant terrain close to the stacks. Buoyancy-induced dispersion, which accounts for the buoyant growth of a plume caused by entrainment of ambient air, will be included in the modeling because of the relatively warm exit temperature and subsequent buoyant nature of the exhaust plumes for both project. Stack-tip downwash, which adjusts the effective stack height downward following the methods of Briggs (1969) for cases where the stack exit velocity is less than 1.5 times the wind speed at stack top, will be selected as per EPA guidance.

As previously mentioned, based on the land use classification procedure of Auer (1978), land use in the region surrounding the project site is greater than 50 percent rural. Therefore, rural dispersion coefficients will be used in the dispersion analyses.

The calm processing option allows the user to direct the program to exclude hours with persistent calm winds in the calculation of concentrations for each averaging period. This option is generally recommended by the EPA (1987b, 1993) for regulatory applications. The ISCST3 model recognizes a calm wind condition as a wind speed of 1 meter per second and a wind direction equal to that of the previous hour. The meteorological preprocessor program (RAMMET) automatically makes this assignment to calm hours. The calm processing option in ISCST3 will then exclude these hours from the calculation of concentrations.

4.4 VISIBILITY SCREENING

The VISCREEN model will asses plume visibility from a specific point. We propose to use the closest point in the Bridge-Teton National Forest, Shoshone National Forest and Wasatch National Forest. A Level 2 screening analysis will be performed using the meteorology data set established for the dispersion modeling described above.

Due to the proximity of structures and buildings to the stack sources, the potential for downwash effects were evaluated to assess close-in ambient air impacts. The formula for GEP height estimation is:

$$H_s = H_b + 1.50L_b$$

Where:

H_s - GEP stack height
H_b - Building height
L_b - The lesser building dimension of the height, length, or width

To determine whether or not a structure (building) potentially affects pollutant dispersion from a nearby emission source, EPA provides specific guidance. The guidance states that, if a structure is located within a certain distance from the emission source (stack), downwash effects on the dispersion of stack emissions must be considered. The distance criteria are the following:

- The emission source is within five times the lesser of the structure height or width when the source is downwind of the structure;
- The emission source is within two times the lesser of the structure height or width when the source is upwind of the structure; and
- The emission source is within one-half the lesser of the structure height or width when the emission source is adjacent to a structure, regardless of the wind flow trajectory.

For this project, an analysis of structures within the proximity of each stack will be performed to ascertain which structure or structures could potentially induce downwash. Based on examination of detailed plot plans for the project for the relationship of sources to the location of plant structures, the locations and dimensions of emission sources and plant structures will be input to a software package, developed by EPA, that evaluates building downwash. The Building Profile Input Program (BPIP) will be used to calculate the direction-specific building dimensions for input into the ISCST3 model. BPIP was designed to incorporate the concepts and procedures expressed in the GEP technical support document (EPA, 1985).

For refined modeling analyses, EPA guidelines require that wind direction-specific building dimensions be input from results of the BPIP GEP runs for each source affected by building downwash. This will account for the sources orientation with respect to a particular building using the Schulman-Scire building downwash algorithm within ISCST3. This allows the model to compare downwash from different structures depending on different wind directions. The projected structure width of the applicable structure is measured at each specified 10° interval (i.e., from 10° clockwise to 360°) by projecting a perpendicular line to an individual wind direction and noting the length of this line from one edge of the structure to the other. Thus, the projected structure width varies by wind direction, while the structure height remains the same. The Schulman-Scire building downwash algorithm is not always invoked by simply supplying building dimensions for each 10° wind direction interval. The ISCST3 model internally checks whether the stack height of the emission source is less than the building heights plus one-half times the lesser of the building height or width. If this condition is not satisfied, then the model defaults to the Huber-Snyder building downwash algorithm and only one set of building dimensions is applied through all wind directions.

The dimensions of the significant structures are not available at this time, and will be provided with the modeling analysis.

The automated receptor grid in SCREEN3 will be used in the screening analysis. This grid will be extended out, as required, to determine the maximum extent of the significant impact area. The maximum extent is then used to define the size of the polar receptor grid used in the refined modeling. The refined receptor grids are concentrated around the maximum impacts predicted in the screening analysis.

The refined modeling analysis will be performed using a polar receptor grid. A polar coordinate receptor grid is consistent with USEPA policy set forth in the Guidelines on Air Quality Models (USEPA, 1986). The polar grid consists of "rings" of receptors placed along 36 directional spokes, which are set at 10° increments. First, a coarse grid of ten “rings” will be used, with receptors placed at downwind distances based on the screening analysis. Additional receptor rings are added if maximum impacts occur at the outer most ring. Areas with the highest predicted concentrations on the coarse polar grid will be modeled further using a dense grid of receptors around these areas to ensure that the highest concentration is found. The dense grid modeling will be conducted with a grid of no less than 100 receptors placed at 100 meter intervals around the points of highest impact in the downwind direction and 5° of arc along the ring. All receptor elevations will be defined based on data obtained from USGS topographic maps.

In addition to the polar receptor grid, discrete receptors will be placed at the nearest plant boundary and in sensitive areas such as schools, hospitals and parks. Since on-site access is restricted, no receptors are placed on Solvay property.

Auer, Jr., A.H. 1978. Correlation of Land Use and Cover with Meteorological Anomalies. *Journal of Applied Meteorology*. 17. Pp. 636-643.

Briggs, G.A. 1969. Plume rise. USAEC Critical Review Series, TID-25075. National Technical Information Service. Springfield, Virginia.

U.S. Environmental Protection Agency. 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. Volumes 1 and II. Office of Air Quality Planning and Standards, Environmental Protection Agency. EPA-454/B-95-003a.

1987b. On-site meteorological program guidance for regulatory modeling application. Office of Air Quality Planning and Standards. Research Triangle Park. EPA-450/4-87-013.

1993. Guideline on Air Quality Models (Revised). Office of Air Quality Planning and Standards, Environmental Protection Agency, Research Park, North Carolina.

1985. Guideline for determination of good engineering practice stack height (Technical Support Document for the Stack Height Regulations). Revised. EPA Publication 450/4-80-023R (NTIS No. PB 85-225241). Office of Air Quality Planning and Standards, Environmental Protection Agency, Research Park, North Carolina.

TABLE 1
NATIONAL AND WYOMING AMBIENT AIR QUALITY STANDARDS

		Wyoming Standards[1] ($\mu g/m^3$)	National Standards[1] ($\mu g/m^3$)	
Pollutant	**Averaging Time**		**Primary[2]**	**Secondary[3]**
Ozone	1-hour	160	235	160
Carbon Monoxide	8-hour	10,000	10,000	10,000
	1-hour	40,000	40,000	40,000
Nitrogen Dioxide	Annual Average	100	100	100
Sulfur Dioxide	Annual Average	60	80	—
	24-hour	260	365	—
	3-hour	1300	—	1300
PM_{10}	Annual	50	50	50
	24-hour	150	150	150
Total Suspended	12-month	—	—	—
Particulates (TSP)	24-hour	150	—	—
Lead	Quarterly	1.5	1.5	1.5

1. The national and Wyoming ozone standards is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard, is equal to, or less than, one. All other annual standards includes those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year.

2. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health. Each state must attain the primary standards no later than three years after that state's implementation plan is approved by the Environmental Protection Agency.

3. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after implementation plan is approved by the EPA.

TABLE 2
CRITERIA POLLUTANT SIGNIFICANT IMPACT LEVELS
($\mu g/m^3$)

Pollutant	Averaging Time				
	Annual	24-Hour	8-Hour	3-Hour	1-Hour
SO_2	1	5	—	25	—
TSP	1	5	—	—	—
PM_{10}	1	5	—	—	—
NO_2[a]	1	—	—	—	—
CO	—	—	500	—	2,000

Source: 40 CFR 52.21(c)

a. The nitrogen dioxide (NO_2) standard regulates nitrogen oxides (NO_x) as NO_2.

TABLE 3
SIGNIFICANT NET EMISSION INCREASE THRESHOLDS

Pollutant	PSD Significant Net Emission Increase Thresholds[1] [2] (tons/year)	Annual Potential Emissions (tons/year)
Carbon Monoxide (CO)	100	
Nitrogen Oxides (NO_x)	40	
Sulfur Dioxide (SO_2)	40	
Particulate Matter (PM)	25	
Volatile Organic Compounds (VOCs)	40	
Sulfuric Acid Mist (H_2SO_4)	7	
Total Reduced Sulfur (including H_2S)	10	
Lead	0.6	
Fluorides	3	

(1) Source: Wyoming DEQ, Chapter I, Section 24

(2) On March 11, 1991, EPA issued transitional guidance (APG 10268) to address some concerns raised by passage of the Clean Air Act Amendments of 1990. Title III of the 1990 amendments added a new Section 112(b)(6) that excludes the HAPs listed in Section 112(b)(1) of the revised CAA (as well as any pollutants that may be added to the list) from PSD. The following pollutants, which had been regulated under PSD, are now exempt from federal PSD applicability: arsenic, asbestos, benzene (including benzene from gasoline), beryllium, hydrogen sulfide, mercury, radio-nuclides (including radon and polonium), and vinyl chloride.

TABLE 4
FEDERAL PSD INCREMENTS

Pollutant and Averaging Period	Class I Increment ($\mu g/m^3$)	Class II Increment ($\mu g/m^3$)
Sulfur Dioxide		
Annual Arithmetic Average	2	20
24-Hour	5	91
3-Hour	25	512
PM_{10}		
Annual Geometric[2] Average	4	17
24-Hour	8	30
Nitrogen Dioxide		
Annual Arithmetic Average	2.5	25

1. Maximum allowable increment may be exceeded once per year at any receptor site.
2. Annual particulate standards were originally promulgated as geometric means. The PM_{10} standard was promulgated as an arithmetic mean; however, the PSD regulations were not updated to reflect this change.

Source: 40 CFR 52.21(c).

TABLE 5
MODEL SELECTION OVERVIEW

Model	Application	Meteorology	Pollutants	Impact Analysis
SCREEN3	Simple and complex terrain screening impacts. Cavity analysis	Screening	All	Screening assessment for selection of emissions profiles
ISCST3	Simple and intermediate terrain impacts.	Rock Springs, WY surface data with Lander, WY upper air data	All	SIL, SIA, NAAQS, PSD
VISCREEN	Visibility assessment	Screening	Particulate	Screening assessment for visibility